

## Taxonomic Studies of *Deutzia* Thunb. (Saxifragaceae s. l.) in Japan 1. Chromosome Numbers

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The chromosome numbers of the following twelve taxa of *Deutzia* have been counted: *D. bungoensis* ( $2n = 52$ ), *D. crenata* var. *crenata* f. *crenata* ( $2n = 130$ ), *D. crenata* var. *crenata* f. *pubescens* ( $2n = 78$ ) and var. *floribunda* ( $2n = 78$ ), *D. gracilis* var. *gracilis* ( $2n = 26$ ), var. *microcarpa* ( $2n = 26$ ), and var. *zentaroana* ( $2n = 52$ ), *D. maximowicziana* ( $2n = 26$ ), *D. scabra* var. *scabra* ( $2n = 26$ ) and var. *sieboldiana* ( $2n = 26$ ), *D. uniflora* ( $2n = 26$ ) and *D. yaeyamensis* ( $2n = 26$ ). Among them seven are diploid ( $2n = 26$ ), two are tetraploid ( $2n = 52$ ), two are hexaploid ( $2n = 78$ ) and one is decaploid ( $2n = 130$ ).

The previously assumed uniformity of the basic chromosome number ( $x = 13$ ) for all taxa of *Deutzia* is supported by the data. Chromosome counts from five taxa, *D. bungoensis*, *D. crenata* var. *crenata* f. *pubescens* and var. *floribunda*, *D. gracilis* var. *microcarpa* and var. *zentaroana*, are new reports, and the counts from the other seven taxa are confirmation of previous counts. It is suggested that ploidy level differentiation is a major factor of speciation in *Deutzia*.

**Key words:** *Deutzia*, chromosome number, ploidy

### Introduction

*Deutzia* Thunb., consisting of 55 species (Zaikonnikova 1966) ranging from Himalaya eastward to East Asia, the Philippines and disjunctly in southern North America to Central America, plays an important role in the vegetation on the margins of thickets, banks, stream sides, and other places in disturbed situations in Japan. Because of taxonomic difficulties and the limited occurrence of some taxa, chromosome information on the specific and intraspecific taxa of *Deutzia* is still limited. Another problem is their cytological variability due to polyploidy and possibly aneuploidy (Ohba and Akiyama 1992, Funamoto and Nakamura 1994). Thus it is difficult to represent the chromosome number of a taxon

by a single count. The taxonomy of the Japanese species of *Deutzia* is still controversial. The present study aims to provide chromosome numbers and other remarkable cytological evidences for elucidating cytological features of the Japanese species of *Deutzia*.

### Material and Methods

All materials were collected in 1997 and 1998, and cultivated in a nursery of the University Museum, University of Tokyo in Tokyo. The vouchers were deposited in the Herbarium of the University of Tokyo (TI). The collecting localities are shown in Table 1. For observations of somatic chromosomes, young root tips were fixed in 45% acetic acid at 0°C for 15 minutes after pre-treatment with a 0.002 M 8-hydroxyquino-

Table 1. Taxa of *Deutzia* examined, their collection localities and chromosome numbers. Vouchers deposited in TI

Taxon	Chromosome numbers (2n)	Locality	Vouchers
<i>D. bungoensis</i>	52	Miyazaki Prefecture, Hinokage-cho, Mitate-keikoku	Minamitani, Kuroki & Niu 9851182
	52	Oita Prefecture, Hasama-cho, along the bank of Yufugawa, near the Tsubakiohashi	Niu 986320
	52	Oita Prefecture, Shonai-cho, Yufugawa-keikoku	Niu 985712
<i>D. crenata</i> var. <i>crenata</i> f. <i>crenata</i>	130	Mie Prefecture, Iitaka-cho Kahadakyo	Niu 97664
	130	Oita Prefecture, Yabakei-cho, Urayabakei	Niu 9742310
<i>D. crenata</i> var. <i>crenata</i> f. <i>pubescens</i>	78	Mie Prefecture, Tado-cho, Tadosan	Niu 988266
	78	Nagano Prefecture, Iida City Tenryukyo	Niu 976161
<i>D. crenata</i> var. <i>floribunda</i>	78	Miyazaki Prefecture, Hinokage-cho, Mitate-keikoku	Minamitani, Kuroki & Niu 9851162
	78	Kumamoto Prefecture, Asosan, Kusa-senri	Niu 984236
	78	Oita Prefecture, Beppu City, Tsurumi Dake	Niu 974221
	78	Oita Prefecture, Takeda City, Kobaru-keikoku	Niu 986211
	78	Oita Prefecture, Yufuin-cho, Yufu Dake	Niu 98562
<i>D. gracilis</i> var. <i>gracilis</i>	26	Aichi Prefecture, Hourai-cho, Atera-no-Nanataki	Niu 988285
	26	Shizuoka Prefecture, Sakuma-cho, Chubutenryu	Niu 9882812
	26	Tokyo Prefecture, Okutama-cho, Unazawa	Niu 9852037
	26	Tochigi Prefecture, Fujiwara-cho, Ryuokyo	Niu 9852918
<i>D. gracilis</i> var. <i>microcarpa</i>	26	Miyazaki Prefecture, Hinokage-cho, Tokawa Dake	Minamitani, Kuroki & Niu 985114
<i>D. gracilis</i> var. <i>zentaroana</i>	52	Kumamoto Prefecture, Itsuki-mura, Ikenozuru	Otomasu & Niu 9842234
	52	Kumamoto Prefecture, Itsuki-mura, Kotsuru	Otomasu & Niu 9842219

Table 1. Continued

Taxon	Chromosome numbers (2n)	Locality	Vouchers
<i>D. maximowicziana</i>	26	Ehime Prefecture, Kuma-cho, Omogokei	Niu 9751424
	26	Hyogo Prefecture, Takarazuka City, Takedao, along the bank of Mukogawa	Niu 9752911
<i>D. scabra</i> var. <i>scabra</i>	26	Kagoshima Prefecture, Kirishima-cho, along the bank of Senri-no-Taki	Niu 974133
	26	Miyazaki Prefecture, Takachiho-cho, Kunimigaoka	Niu 974317
	26	Miyazaki Prefecture, Kushima City, Toimisaki	Niu 974213
	26	Ehime Prefecture, Ipponmatsu-cho, Sasayama	Niu 9751321
	26	Kochi Prefecture, Touwa-mura, Toukawa, along the bank of Shimantogawa	Niu 975128
	26	Tokushima Prefecture, Anan City, Tsuruminesan	Niu 975168
	26	Mie Prefecture, Itaka-cho, Kahadakyo	Niu 976625
	26	Tokyo Prefecture, Okutama-cho, Unazawa	Niu 9852016
<i>D. scabra</i> var. <i>sieboldiana</i>	26	Nagasaki Prefecture, Obama-cho, Unzen Dake	Niu 9842411
	26	Kumamoto Prefecture, Itsuki-mura, Seme	Otomasu & Niu 9842234
	26	Miyazaki Prefecture, Aya-cho, near the Ayaohashi	Niu 984204
<i>D. uniflora</i>	26	Tokyo Prefecture, Okutama-cho, Nippara, Ogawadani	Shimizu & Niu 985269
<i>D. yaeyamensis</i>	26	Okinawa Prefecture, Iriomote Island	Kobayashi & Endo 331

line solution at 20°C for 4 hours. The materials were hydrolyzed in 1:1 mixture of 45% acetic acid and 1 N HCl at 60°C for 2 minutes and transferred to 2% aceto-orcein for staining. Suitable cells were analyzed, drawn and photographed using a Nikon microscope (AFM-B). The taxonomic treatment essentially follows Ohba (1989a).

### Results and Discussion

The results of the chromosome counts are

shown in Table 1. Some comments on the results and taxonomic implications follow.

#### 1) *Deutzia crenata* Siebold & Zucc.

The chromosomes of *D. crenata* var. *crenata* f. *crenata* were studied in plants collected from two locations, in Mie and Oita Prefectures, and were  $2n = 130$ . The same chromosome numbers were reported by many authors (Schoennagel 1931, Hamel 1953, Tanaka 1974, Terasaka and Tanaka

1974, Funamoto and Nakamura 1994). Funamoto and Nakamura (1994) reported  $2n = 78$  from the same form. These counts were all obtained from wild plants collected from various localities in Japan, and are considered to be hexaploid and decaploid, respectively.

*Deutzia crenata* f. *pubescens* (Makino) H.Hara, distributed sporadically in Kinki and Chubu districts, had  $2n = 78$  chromosomes. At mitotic metaphase, the chromosomes are short ranging between about 1.0  $\mu\text{m}$  and 2.1  $\mu\text{m}$  in length. No satellite chromosomes were observed (Fig. 1-A). This form differs from f. *crenata* by having spreading hairs on the midrib of the lower surface of the leaves.

*Deutzia crenata* var. *floribunda* (Nakai) H.Ohba, distributed in Kii Peninsula, Shikoku and Kyushu, was once regarded as a distinct species by Zaikonnikova (1966) and Hara (1986). Ohba (1989b) treated it as a variety and segregated it from var. *crenata* because of its compact inflorescences with many smaller flowers (7–10 mm across) produced from June to August, spreading petals 4–6 mm long, filaments without distinct teeth, smaller capsules about 3 mm across, and dwarf habit. The chromosome number of the variety is also  $2n = 78$  at mitotic metaphase. The chromosomes are short and gradually vary in length between about 1.1  $\mu\text{m}$  and 2.1  $\mu\text{m}$ . Two satellites were observed on the pair of submedian-centromeric chromosome (Fig. 1-B). This is the first chromosome count for this variety.

## 2) *Deutzia gracilis* Siebold. & Zucc.

*Deutzia gracilis* is distributed in Honshu westwards from Kanto and Chubu districts to Shikoku and Kyushu. Four varieties, var. *gracilis*, var. *ogatae* (Koidz.) Ohwi, var. *zentaroana* (Nakai) Hatus. and var. *pauciflora* Sugim. are recognized by Ohba (1989a). Hatusima (1989) provisionally proposed a new variety, var. *microcarpa*, which

is found only in Oita and Miyazaki Prefectures in Kyushu (Hatusima 1989). Except for var. *gracilis* no other chromosome counts have been reported. Chromosome numbers  $2n = 26$  or  $n = 13$  were previously reported for var. *gracilis* (Schoennagel 1931, Sax 1931, Funamoto and Nakamura 1992). The same diploid chromosome number,  $2n = 26$  (Fig. 1-C), was counted for var. *gracilis* collected from Chubu and Kanto districts in this study. The chromosomes are short, ranging from approximately 1.1  $\mu\text{m}$  to 2.0  $\mu\text{m}$  long.

In this study, we collected *D. gracilis* var. *zentaroana* from Kyushu (Kumamoto Prefecture) and found  $2n = 52$  chromosomes (Fig. 1-D). The chromosomes are short, ranging from approximately 0.8  $\mu\text{m}$  to 1.6  $\mu\text{m}$  long. This is the first count for this variety.

We collected plants that are regarded as var. *microcarpa* Hatus. at Tokawadake in Miyazaki Prefecture and counted  $2n = 26$  chromosomes (Fig. 1-E) for the first time. The chromosomes are short, ranging from approximately 1.0  $\mu\text{m}$  to 1.8  $\mu\text{m}$  long.

## 3) *Deutzia scabra* Thunb.

*Deutzia scabra* var. *scabra* is distributed widely in Honshu westwards from Kanto and Chubu districts to Shikoku and Kyushu. A chromosome number of  $2n = 26$  has been reported by Funamoto and Nakamura (1992), and of  $n = 65$  by Sax (1931) and Singhal et al. (1980). In this study, we collected this variety from Kanto, Kinki, Shikoku and Kyushu, and counted  $2n = 26$  chromosomes (Fig. 2-A). The chromosomes are short, ranging from approximately 1.8  $\mu\text{m}$  to 2.2  $\mu\text{m}$  long.

Another variety, var. *sieboldiana* (Maxim.) H.Hara, endemic to Kyushu, is distinguished from var. *scabra* by the oblong or oblong-ovate leaves with acuminate apex, and the dense spreading hairs on the inflorescence axis and calyx tube. A chromosome

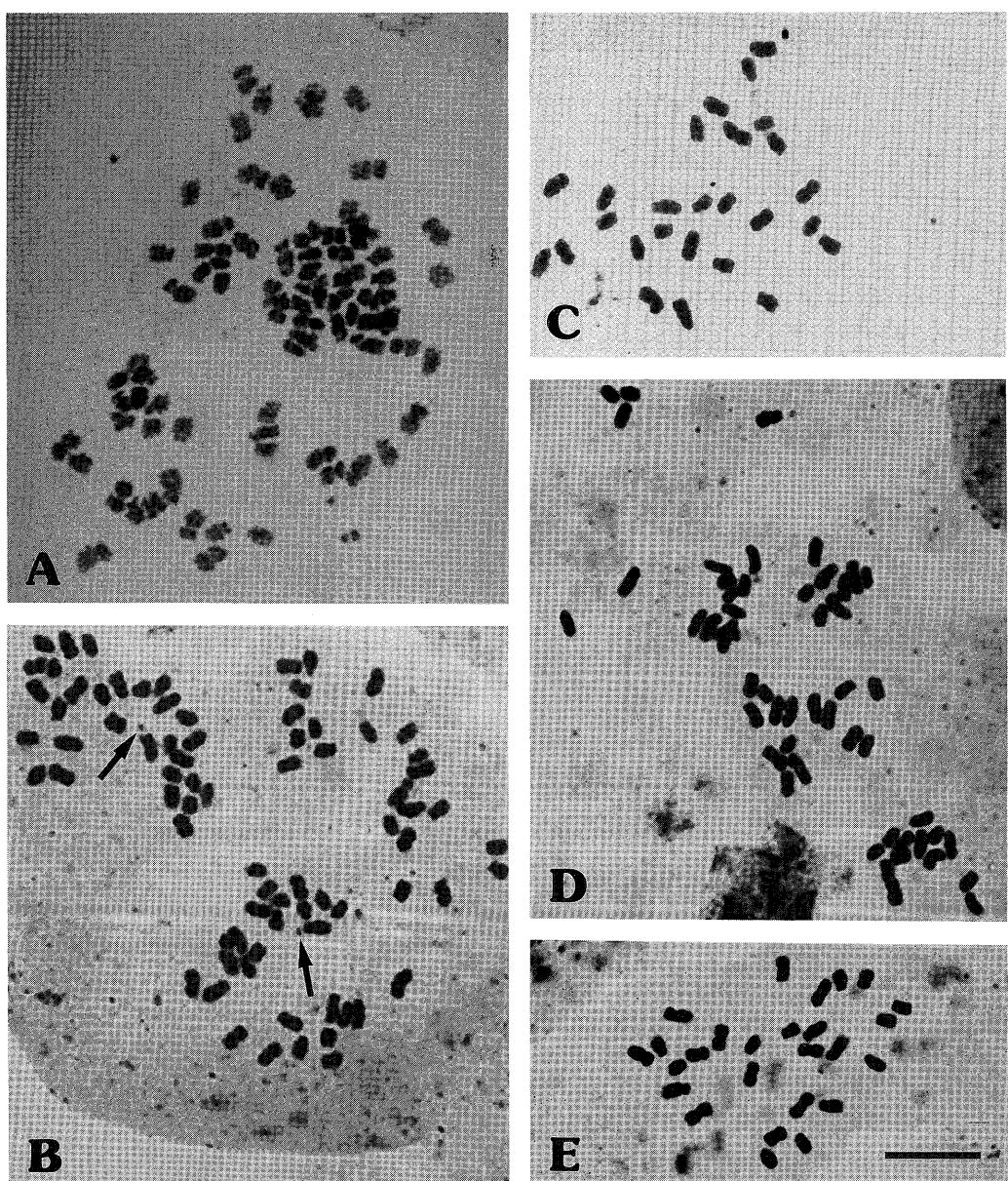


Fig. 1. The somatic chromosomes of *Deutzia*. A. *D. crenata* var. *crenata* f. *pubescens*,  $2n = 78$  (Mie Prefecture, Tado-cho, Tadosan, Niu No. 988266). B. *D. crenata* var. *floribunda*,  $2n = 78$  (Oita Prefecture, Beppu City, Tsurumi Dake, Niu No. 974221). C. *D. gracilis* var. *gracilis*,  $2n = 26$  (Tochigi Prefecture, Fujiwara-cho, Ryuokyo, Niu No. 9852918). D. *D. gracilis* var. *zentaroana*,  $2n = 52$  (Kumamoto Prefecture, Itsuki-mura, Ikenozuru, Otomasu & Niu No. 9842234). E. *D. gracilis* var. *microcarpa*,  $2n = 26$  (Miyazaki Prefecture, Hinokage-cho, Tokawa Dake, Minamitani, Kuroki & Niu No. 985114). Arrow indicates satellite. Bar = 5  $\mu$ m.

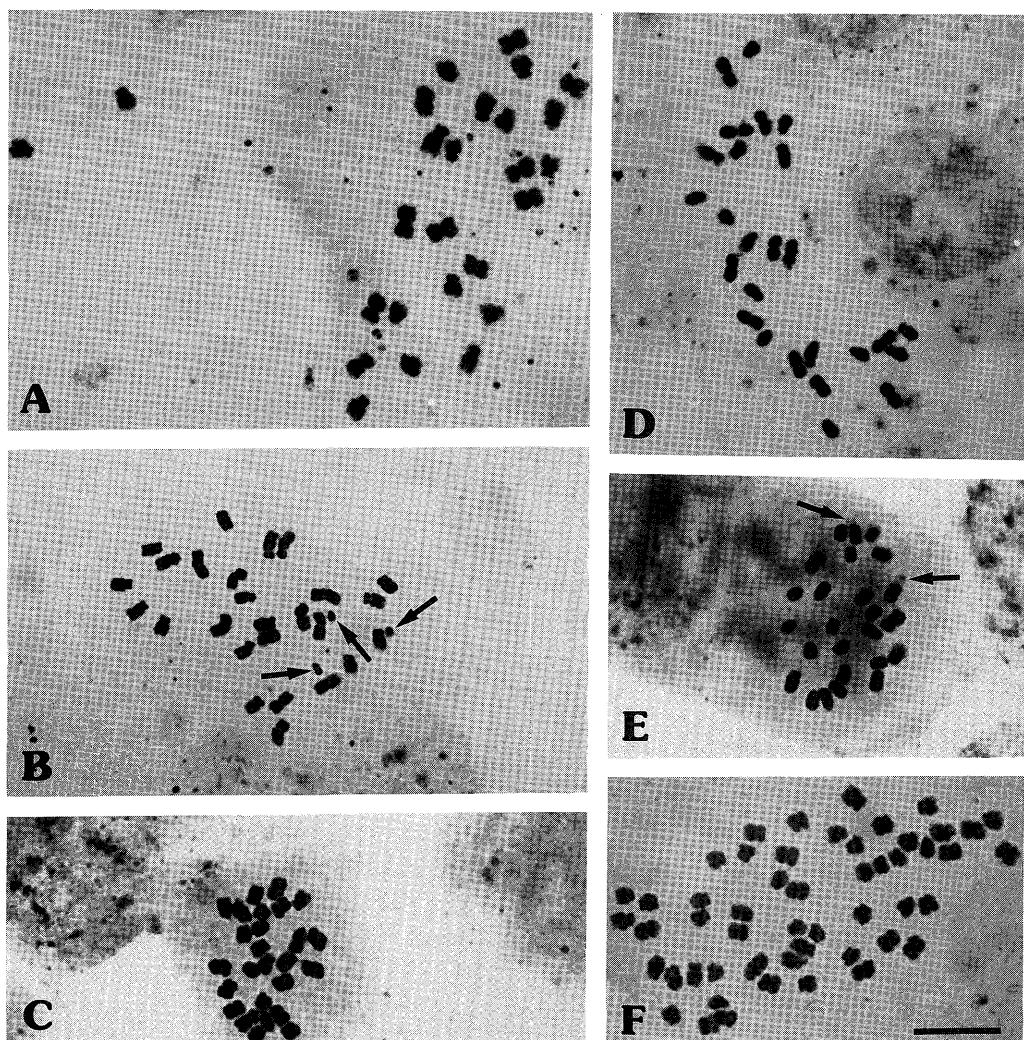


Fig. 2. The somatic chromosomes of *Deutzia*. A. *D. scabra* var. *scabra*,  $2n = 26$  (Kagoshima Prefecture, Kirishima-cho, Niu No. 974133). B. *D. scabra* var. *sieboldiana*,  $2n = 26$  (Nagasaki Prefecture, Obama-cho, Unzen Dake, Niu No. 9842411). C. *D. maximowicziana*,  $2n = 26$  (Ehime Prefecture, Kuma-cho, Omogokei, Niu No. 9751424). D. *D. uniflora*,  $2n = 26$  (Tokyo Prefecture, Okutama-cho, Nippara, Ogawadani, Shimizu & Niu No. 985269). E. *D. yaeyamensis*,  $2n = 26$  (Okinawa Prefecture, Iriomote Island, Kobayashi & Endo No. 331). F. *D. bungoensis*,  $2n = 52$  (Miyazaki Prefecture, Hinokage-cho, Mitate-keikoku, Minamitani, Kuroki & Niu No. 9851182). Arrow indicates satellite. Bar = 5  $\mu$ m.

number of  $2n = 26$  (Fig. 2-B) was counted in this variety. The chromosomes are short, ranging from approximately 1.1  $\mu$ m to 2.0  $\mu$ m long. The same chromosome number was reported by Sax (1931) under *D. sieboldiana* (Sax 1931), but the satellites that are found on three submedian-centro-

meric chromosomes were not mentioned by him.

#### 4) *Deutzia maximowicziana* Makino

The chromosomes of *D. maximowicziana* were studied in plants collected in two localities, Honshu (Kinki district) and

Shikoku. They had a chromosome number of  $2n = 26$  (Fig. 2-C), as reported by Funamoto and Nakamura (1994). The chromosomes are short, ranging from approximately 1.0  $\mu\text{m}$  to 2.0  $\mu\text{m}$  long.

#### 5) *Deutzia uniflora* Shirai

The chromosome number of *D. uniflora* was counted as  $2n = 26$  (Fig. 2-D). The chromosomes are short, ranging from approximately 1.0  $\mu\text{m}$  to 2.0  $\mu\text{m}$  long. *Deutzia uniflora* is endemic to the Kanto district in Honshu, and is characterized by inflorescences with 1 or 2 flowers and the stalked stellate hairs, but the distinguishing characters from its close allies are still unclear. *Deutzia uniflora* was classified in subsect. *Grandiflorae* Rehd. by Hwang (1993), together with three other species: *D. grandiflora* Bunge from China, *D. hamata* Koehne from China and Korea and *D. coreana* H.Lév. from Korea. Among them,  $2n = 78$  was counted from *D. coreana* by Hamel (1953) and  $2n = 26$  was reported from *D. hamata* by Zaikonnikova (1966), but the chromosome number of *D. grandiflora* has not been reported.

#### 6) *Deutzia yaeyamensis* Ohwi

This is endemic to Iriomote-jima, the southernmost island of the Ryukyu Islands. Ohba and Akiyama (1992) reported  $2n = 26$ . In this study the same chromosome number was counted, but satellites were found on one pair of submedian-centromeric chromosomes (Fig. 2-E). The chromosomes are short, ranging from approximately 1.1  $\mu\text{m}$  to 1.7  $\mu\text{m}$  long.

#### 7) *Deutzia bungoensis* Hatus.

In this study we collected so called *D. × bungoensis* Hatus., which was regarded as a natural hybrid between *D. crenata* var. *floribunda* (Nakai) H.Ohba (= *D. nakaii* Engl.) and *D. scabra* var. *sieboldiana* (Maxim.) H.Hara (= *D. sieboldiana* Maxim.) by

Hatusima (1954), and counted  $2n = 52$  chromosomes (Fig. 2-F) for the first time. The chromosomes are short, ranging between 0.9  $\mu\text{m}$  and 1.9  $\mu\text{m}$  long.

### General Discussions

Ohba (1989a) classified Japanese *Deutzia* into seven species, seven varieties, six forms and two hybrids. Three species, *D. crenata*, *D. gracilis* and *D. scabra*, which are widely distributed throughout Japan westwards from Honshu, are extremely variable in several morphological characters such as the shape and size of the flowers, leaves, trichomes and habit. The basic chromosome number of *Deutzia* is  $x = 13$ , as reported by Sax (1931), and tetraploids have been reported from *D. naseana* var. *naseana* and var. *amanoi* by Ohba and Akiyama (1992), and Funamoto and Nakamura (1992), hexaploids from *D. crenata* var. *crenata* by Funamoto and Nakamura (1994), and decaploids from *D. crenata* var. *crenata* and *D. scabra* var. *scabra* by Schoennagel (1931), Sax (1931), Hamel (1953), Tanaka (1974), Terasaka and Tanaka (1974), Singhal et al. (1980), and Funamoto and Nakamura (1994). This study reveals that ploidy level differentiation has occurred in two Japanese species of *Deutzia*, *D. gracilis* and *D. crenata*.

In *D. crenata*, a form and a variety, f. *pubescens* and var. *floribunda*, have  $2n = 78$  (hexaploid), while f. *crenata* has been reported to have  $2n = 130$  (decaploid) and  $2n = 78$  (hexaploid) chromosomes. In *D. gracilis*, var. *zentaroana* is  $2n = 52$  (tetraploid), while var. *microcarpa* and var. *gracilis* are  $2n = 26$  (diploid). It is noted that all the varieties from the floristic region named Sohayaki Region (Maekawa 1974) are diploid in *D. gracilis* and *D. scabra*, and the lowest ploidy level in *D. crenata*. The Sohayaki Region is known to be a natural reserve of relict and ancient elements that show a peculiar affinity with the continent-

tal flora of southwest China. From the distribution pattern of intraspecific taxa and ploidy levels it is suggested that ploidy level differentiation is an important factor in speciation in *Deutzia*.

The chromosomes of *D. bungoensis* were counted as  $2n = 52$  (tetraploid), and these of *D. scabra* var. *scabra* and var. *sieboldiana* were  $2n = 26$  (diploid), all though  $n = 65$  (decaploid) was reported for var. *scabra* by Sax (1931) and Singhal et al. (1980). *Deutzia bungoensis* has large paniculate inflorescences and small capsules similar to those of *D. crenata* var. *floribunda* and also contracted petioles and stellate hairs on the leaves similar to those of *D. scabra* var. *sieboldiana*. The tetraploid chromosome number,  $2n = 52$ , does not deny its hybrid origin between *D. crenata* var. *floribunda* and *D. scabra* var. *sieboldiana* as suggested by Hatusima (1954) based on gross morphology.

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鉢 力明, 大場秀章:日本産ウツギ属(ユキノシタ科)の分類学的研究 1. 染色体数

オオシマウツギ (*Deutzia naseana*) を除く、日本産ウツギ属(ユキノシタ科) 7種とその4変種1品種について染色体数を観察した。染色体数を観察した分類群と染色体数は次の通りである。 *D. bungoensis* ( $2n = 52$ ), *D. crenata* var. *crenata* f. *crenata* ( $2n = 130$ ), *D. crenata* var. *crenata* f. *pubescens* ( $2n = 78$ ), *D. crenata* var. *floribunda* ( $2n = 78$ ), *D. gracilis* var. *gracilis* ( $2n = 26$ ), *D. gracilis* var. *microcarpa* ( $2n = 26$ ), *D. gracilis* var. *zentaroana* ( $2n = 52$ ), *D. maximowicziana* ( $2n = 26$ ), *D. scabra* var. *scabra* ( $2n = 26$ ), *D. scabra* var. *sieboldiana* ( $2n = 26$ ), *D. uniflora* ( $2n = 26$ ), *D. yaeyamensis* ( $2n = 26$ )。上記のうち、7分類群が2倍体、2分類群が4倍体、2分類群が6倍体、1分類群が10倍体であった。

今回の種間又は種内分類群の染色体の観察結果から、染色体基本数を  $x = 13$  とする従来の説が支持された。染色体を調べた分類群のうち、5分類群、*D. bungoensis*, *D. crenata* var. *crenata* f. *pubescens* と var. *floribunda*, *D. gracilis* var. *microcarpa* 及び var. *zentaroana* は今回が初めての染色体数の報告である。いずれの分類群においても染色体は小さく、長さは  $0.8\text{--}2.2\text{ }\mu\text{m}$ 、次端部動原体型と次中部動原体型及び中部動原体型で、付随体は *D. crenata* var. *floribunda*, *D. yaeyamensis*, *D. scabra* var. *sieboldiana* で観察された。本研究は日本産ウツギ属では倍数性が種分化の重要な役割を演じていることを示唆している。

(東京大学総合研究博物館植物部門)